

Low-energy RHIC electron Cooler (LEReC) progress updates

March 7, 2017:

DC Gun tests:

- Preparation for DC gun tests with beam is underway.
- Gun cathode side and gun-to-booster side vacuum baking finished on March 1, which now allows remaining work on cables connections and testing to continue. This is being done when access to RHIC tunnel becomes available.
- DC Gun high voltage test: voltage went up right away to where it was left back in December.
- DC Gun Power Supply inverter has problems and is under repairs.

Physics Support:

- Preparation for commissioning with beam.
- Most of operational and testing procedures prepared.
- Magnetic measurements along beam line showed the need to shield ion pump in extraction line.

MPS:

- The MPS documentation was finalized
- We finalized the MPS testing and commissioning procedures (the procedures are going through the last iteration prior to making them official)
- The logic of the MPS controller itself was checked and adjusted by Zeynep Altinbas following the commissioning procedures
- The logic of the FCT processor allowing for accumulation of the charge data in a few second moving window was devised and implemented by Kevin Mernick and Winston Pekrul.

HLA development:

- Working on accelerator physics library of the LEReC online model with a simple space charge simulations.

Simulations:

- Verified PARMELA and GPT lattice files against Drawings, rematched optics where necessary. Matched dump section to avoid beam loss in the wrong places. Added bpm's and dipole correctors to the GPT input files. Python orbit correction program based on svd, using GPT as a machine simulator.

DC gun and cathode insertion system:

- Finished the bake-out and the leak-check for the puck insertion system in the tunnel. The system is ready for the extraction of the dummy puck from the gun.
- Fabricated a modified shaft support for the magnetic manipulators and a thicker puck stop to be installed in the puck drive assembly. These parts are ready for the installation.
- Ordered and installed a low-torque slip clutch on the manually-driven stage of the puck drive assembly to 'feel' any interference while inserting a puck into the gun.

- Received a total of 34 new and polished molybdenum pucks from the vendor.
- Received the complete order for the gun HV processing resistors from Nicrom Electronics.
- Placed an order for a few limit stops to guide the travelling arm in the magnetic manipulator better.
- Started assembly of Ferris wheel multi-cathode suite in Bldg. 919B.

Cathodes:

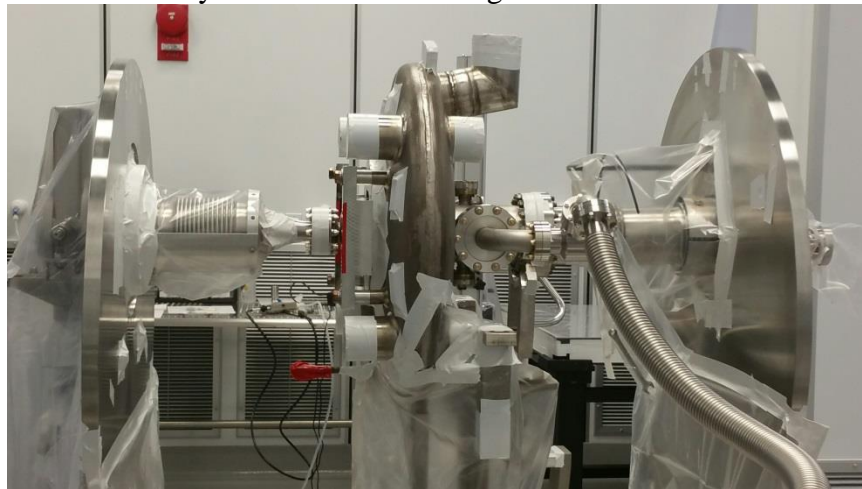
- Cathode is ready and awaiting transport to RHIC IR2 for beam tests.

Laser:

- Administration:
 - Standard Operating Procedure (SOP) for LEReC and CeC lasers completed (reference: <http://www.c-ad.bnl.gov/esshq/snd/opm/Ch23/23-07.PDF>)
 - laser interlock test in 1002F completed
 - laser-related ASSRC checkoff list items completed
- Laser development:
 - completed construction of laser amplifier (main amplifier and all pre-amplifiers)
 - completed development of 1002F laser diagnostics including measurements of
 - pulse train duration using an ultrafast diode and scope
 - optical spectrum of the laser beam (around the central wavelength) using an optical spectrum analyzer
 - rf spectrum to characterize the mode-locked signal and its 704 MHz sideband using an ultrafast diode, RF amplifier and RF spectrum analyzer
 - laser pulse duration using autocorrelator
 - nearing completion of the high-power Pockels cell, intensity control and crystal pulse shaping setups
- Laser transport:
 - awaiting final laser alignment (into gun-to-booster vacuum chamber to cathode then to laser exit table) to be performed after bake-out and vacuum gate valve opened
 - began measurements of long-term laser pointing stability between 1002F trailer and gun table, 1002F trailer and relay table
- Laser integration:
 - continuing cable terminations for remote control and diagnostics (mirror motion control, power meters, cameras etc.)
 - continuing hookup of laser control and diagnostics devices to the network
 - developing associated pet pages for online viewing, control and logging
 - preparing for system test of timing control and connection to LEReC MPS system

RF cavities:

- **2.1 GHz Warm RF Cavity**
 - Cavity assembly is completed and leak checked. Cavity ion pump installed. Waiting for vacuum group to connect cable and setup the controls.
 - Water group started the water installation. The manifolds are installed but the connections between the cavity and the manifolds are still missing.
 - Still having issues with the combiner of the amplifier for the cavity. With a match load, they were able to get 12KW.
 - We were able to do some high power test of the RF window at 5KW and 2.1GHz. The amplifier trips at around 5KW with fully reflected power. We still plan to do the high power test when the amplifier is ready.
 - We are planning to do some conditioning on the cavity with the amplifier as is.
- **704 MHz Warm RF Cavity:**
 - Cavity is being assembled in 925.
 - Tuner plunger delivery delayed to mid March.
 - Vacuum FPC waveguide adapter delivery has been delayed to Mid March.
 - Coax layout is near completion. The final connections will be done when the cavity is moved into the tunnel.
 - Custom elbow and RF shielded adapter have installed on the cavity.
 - Amplifier has been delivered.
- **704 MHz Deflecting Cavity**
 - PO has been awarded to RI.
 - Final Design review is scheduled for March 8th.
 - Design of the tuner is completed. Drawings on the way.
 - Delivery: September
- **SRF Booster cavity**
 - Under assembly in clean room of Bldg. 912:



Power Supplies:

- DC Gun
 - 1) Problems with the Power Supply. Inverter has been removed. A and C fuses replaced, contactor replaced. Other troubleshooting continues.
 - 2) Received the spare inverter from Cornell. Need to make sure it will work with our control chassis if we ever think we will need to use it alone.
- LEReC Beam line
 - 1) The PO has been placed for the individual power supplies needed for the low field compensating solenoids in the cooling section. Should be here by end of March 2017.
 - 2) For DC gun test beamline all of the existing magnets and power supplies are wired up at both ends except for 2 more correctors that were installed later. These correctors still need to be wired up in the tunnel. Need to label the racks with the ps names. The 45 degree dipole ps was tested but the rest of the p's must still be tested. The other ps's will be tested once the bakeout equipment has been removed.

Beam Instrumentation:

- **Cathode Imaging:** design & assembly complete, installation awaiting vacuum conditioning
- **Profile Monitors:** all vacuum components installed, 4th PM complete, 3rd PM complete & partially tested, 1st & 2nd PMs' controls & optics awaiting bakeout completion.
- **Emittance Slit:** Installed but mechanical modification requires new components – on order.
- **BPMs:** Electronics in house installed, buttons installed & connected, local amplifier installation pending.
- **Current Transformers:** FCTs, ICT, DCCT installed and connected to electronics
- **Faraday Cup** all installed, all connected to electronics except for FC in 1st PM (awaiting bakeout)
- **NMR probe** delivery expected beginning of March.
- **Radiation detectors** Canberra GMTs installed and operating.
- **Halo Monitors** installed, cabled and tested.
- **Solenoid Motion control** installed & cabled, testing pending.
- **PMT loss monitors** Fiber scintillators constructed, installation pending new brackets, electronics to be installed in early March.
- **Diagnostic B/L** Profile monitor preliminary design reviewed, final design underway.

Controls:

QE scan

- motion coordination manager testing is required with field equipment
- application development has been delayed by other tasks

Power Supplies

- we have been supporting PS configuration and checkout by the PS Group

Vacuum

- basic support for reading pressure from the IM540 vacuum gauge (new Leybold Extractor type) has been developed... testing with the field equipment should be happening shortly

- ADO manager software has been prepped for the LEReC valve PLC configuration and is ready for testing with the field equipment when it is available

Laser

- the filter wheel software interface is ready for field testing
- continuing to work with experts on defining the channel assignments for laser and diagnostics controls in 1002d and 1002f in preparation for testing with the field equipment
- laser beam iris controls have been demonstrated in the lab using a stepper motor controller used for other systems in a scheme developed by Lenny DeSanto, which leverages our existing motor controller software

Timing

- will use to adapt the CeC Timing ADO manager to the specific requirements for LEReC
- lower-level pet page controls have been configured

Instrumentation

- BPM ADO manager and application controls are fully available... questions of logging and accessing logged data are being discussed
- work continues on configuring BLM systems, though software development is needed at the manager and application levels as well
- the Zynq platform for the FCTs, etc. is installed and running out at 1002d, and has been tested in conjunction with the MPS using fake input data... calibration has not been performed yet
- Laser/e-beam Profile Monitor cameras are being brought online... additional database and pet page configuration is needed this week
- mux and scope interface controls (RemoteScope application) have been configured and made available for Instrumentation Group checkout

MPS

- A Syndi display has been created to simplify the user interface (from pet, a link available under Applications... will add to StartUp too)

Cryogenics:

Mechanical hardware

- Cryogenic transfer line system for Booster cavity cryostat: Drawings and mods received from vendor and approval to finish detailed drawings and proceed with manufacturing given. Pipe stress analysis started. Schedule update to follow. Delivery first week in June. Delivery may split in 2 if the return line fabrication lags. We will get the supply line first to install.
- 5 x Return heaters for the 5K intercepts cooling circuits: Requisition to be issued (8 weeks delivery)
- 5K circuit heaters vacuum jacketed assembly drawings to be completed to go out for quotation. 3 months. June. Cannot be installed until Cryostat is in place.
- Large return heater for 4.5K subcooler vapor return: Received.
- Warm piping system valves: ordered. 3 inch Actuated Ball valve received
- Piping supports: to be ordered.

Controls and Instrumentation:

- Control logic engineering document completed.

UL listed Heater 5 zone control panel for the 5K circuit return heaters and Large heater

Control Panel: Received.

- Pressure transducers partial shipment received.
- Misc Rack parts ordered, I/O cards, Cables tunnel to racks ordered

Beam dumps:

Continued effort to design extraction line and Dump shielding

Continued effort to analyze Gun diagnostic dump for various beam parameters.

Installation and other Design work summary:

- DC Gun tests beamline:

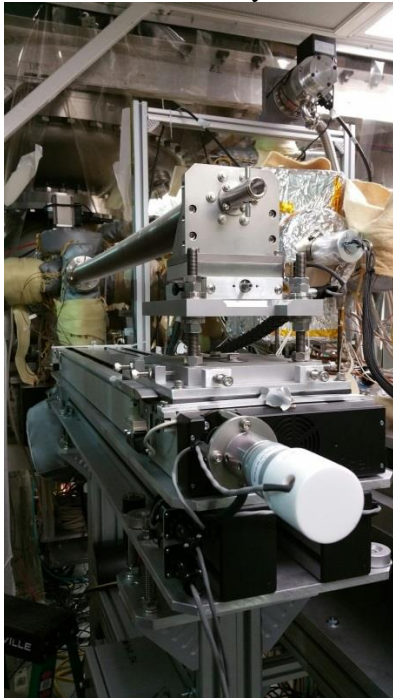
DC gun beamline was closed on February 14.

Vacuum baking for the cathode and gun-to-booster sections was done Feb.14-March 1.

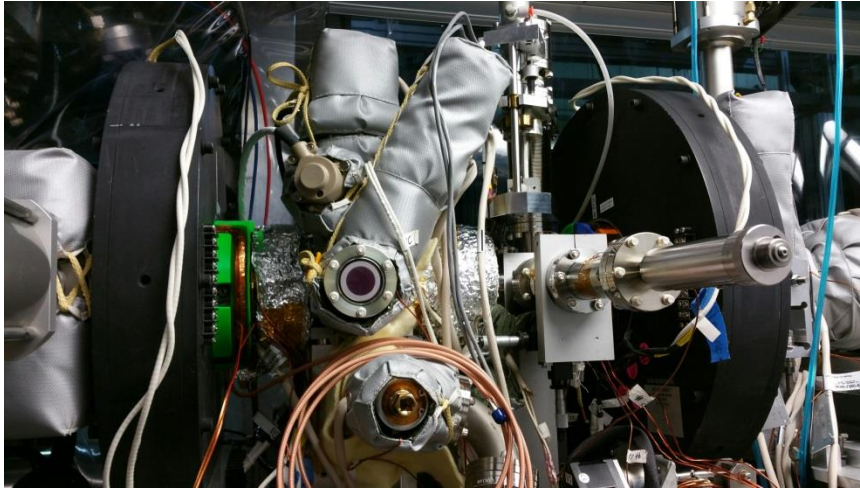
Baking of remaining transport section to be completed March 9.

Cable connections and testing of equipment is underway.

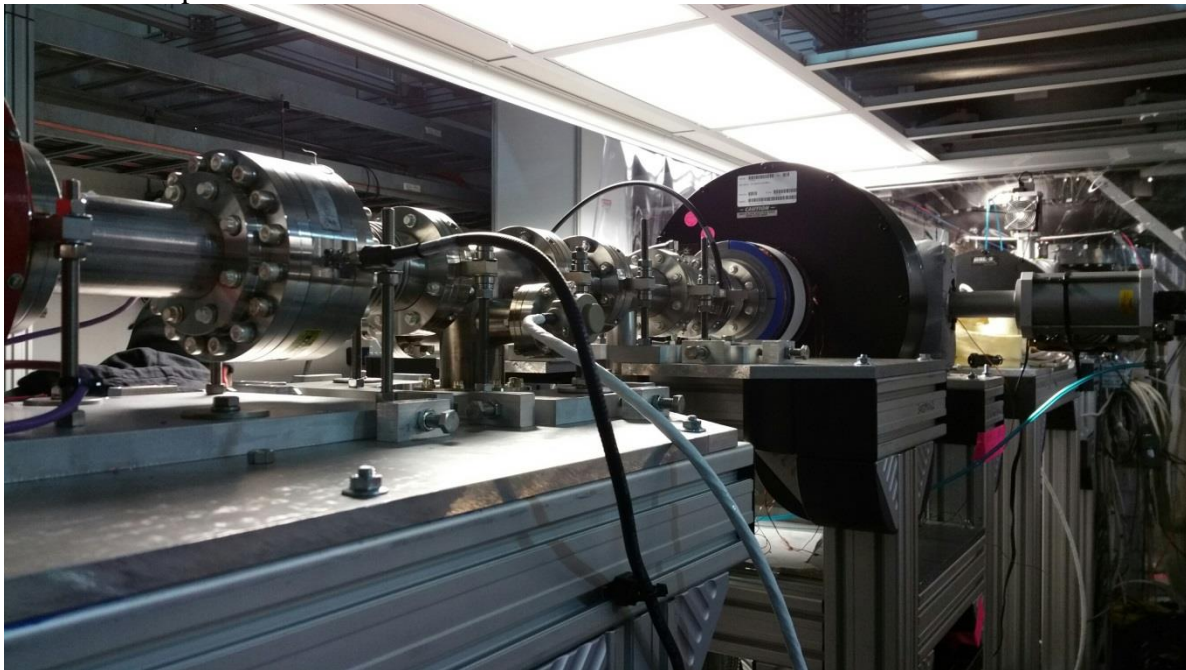
Cathode insertion system in front of the Gun:



Gun-To-Booster section:



DC Gun transport beamline:



- Design work and installation planning is underway for summer RHIC shutdown:
 - Transport line & cooling sections
 - Diagnostics beamline
 - Extraction beamline